Linear Momentum and collisions

Phys109

Fall 2019

1. A 0.14 kg baseball is dropped and reaches a speed of 1.2 m/s just before it hits the ground. It rebounds with a speed of 1 m/s. What is the change of the ball's momentum? If the contacting time is 0.1 second, what is the average force? (Answer: 0.308, 0.031)

2. An 1 kg object travelling east at 1 m/s collides head on with a 2 kg object travelling west at 2 m/s. Find the velocity of two objects just after collision if the collision is perfectly inelastic. (Answer: $= -\hat{i}$m/s)

3. A 900 kg car travelling east at 15 m/s collides with a 750 kg car travelling north at 20 m/s. The cars stick together.

   (a) What is the speed of the wreckage just after the collision? (12 m/s)

   (b) In what direction does the wreckage move just after the collision? (48°)

   (c) What is the energy lost?(132,450 J)

4. In the overhead view, a 300 g ball with a speed v of 6 m/s strikes a well at an angle θ of 30° and then rebounds with the same speed and angle. It is contact with the wall for 10 ms. In unit vector notation, what are

   (a) the impulse on the ball from the wall? ($1.8\hat{j}$ kgm/s)

   (b) the average force on the wall from the ball? (180 N)

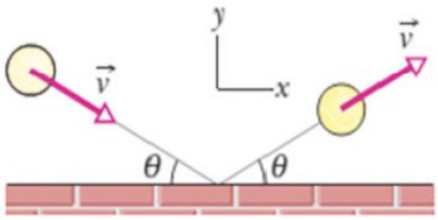

Figure 1: Problem no.4

5. The ballistic pendulum is an apparatus used to measure the speed of a fast-moving projectile, such as a bullet. A bullet of mass 20 g with 200 m/s is fired into a large block of wood of mass 480 g suspended from some light wires. The bullet embeds in the block, and the entire system swings through a height h. Find the max height? (3.26 m)

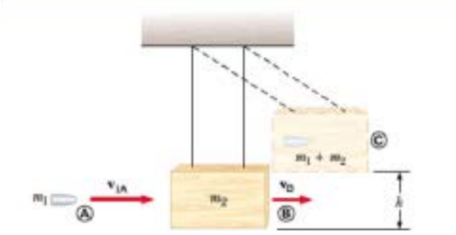

Figure 2: Problem no.5

6. A truck of mass 6000kg is traveling at a velocity of $\overrightarrow{v_{1i}} = 25\hat{i}$ collides with a car of mass 1200kg traveling at a velocity $\overrightarrow{v_{2i}} = 20\hat{i}$. The velocity of the truck after the collision is $\overrightarrow{v_1} = 22\hat{i}$.

   (a) Calculate the velocity of the car after collision.

   (b) If the collision lasted for 0.4 s what is the average force exerted by the car on the truck?
   (answer: -45kN)

   (c) Calculate the lost kinetic energy. (answer: -72kJ)

7. Two chunks of ices sliding on a frictionless frozen pond. Chunk A with mass 5 kg moves with initial velocity 2 m/s parallel to the x-axis. It collides with chunk B, which has mass 3kg and is initially at rest. After the collision, the velocity of chunk A is 1 m/s in a direction making an angle 30 with the initial direction. What is the final velocity of chunk B? (Answer: $\overrightarrow{v} = 3.06\hat{i} - 0.16\hat{j}$m/s)

8. A tennis player strikes the tennis ball with her racket while the ball is still rising. The ball speed before impact with the racket is $v_1 = 15m/s$and after the impact its speed is$v_2 = 22m/s$, with directions as shown in the figure. If the mass 60 g ball is in contact with the racket for 0.05 s.

   (a) Determine the momentum of the ball just before it is stroke by the racket. (answer:$-0.89\hat{i} + 0.16\hat{j}\ kgm/s^2$)

   (b) Determine the momentum of the ball just after it is stroke by the racket. (answer:$1.24\hat{i} + 0.45\hat{j}\ kgm/s^2$)

   (c) Determine the magnitude of the average force exerted by the racket on the ball. (answer:$42.534\hat{i} + 5.9\hat{j}\ kgm/s^2$)

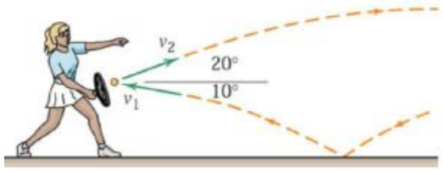

Figure 3: Problem no.8

9. A large block of wood of mass 5.4 kg hanging from two long cords. A bullet of mass 9.5 gr is fired into the block, coming quickly to rest. The block +bullet then swing upward, their center of mass rising a vertical 6.3 cm before the pendulum comes momentarily to rest at the end of its arc. What is the speed of the bullet just prior of the collision. (answer: 632.75m/s)

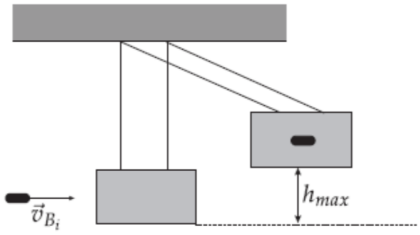

Figure 4: Problem no.9

10. A bullet of mass $m = 5.2g$ and velocity $v_{B0} = 500m/s$hits a block of wood of mass $M = 700g$ at rest on a frictionless surface. The bullet emerges from the block at a velocity of $v_B = 300m/s$.

Figure 5: Problem no.10

(a) Calculate the velocity of the block after the collision. (answer:$1.49\hat{i}$ m/s^2)

(b) Calculate the impulse on the block. (answer:$1.043\hat{i}$ m/s^2)

(c) Calculate the impulse on the bullet. (answer:$-1.043\hat{i}$ m/s^2)

(d) Calculate the change of the total kinetic energy of the system, and state whether the collision was elastic or inelastic. (answer:-415.2J)